



NASA STTR 2011 Phase I Solicitation

T7 Ground Effects of Launch Acoustics, Payload Integration, and Flexible Polymer Foam Systems

Kennedy Space Center (KSC) is seeking innovative solutions to improve ground systems operations. This topic highlights three areas that KSC has a vested interest. These include: improved performance of materials for cryogenic insulation, fireproofing, energy absorption, and other aerospace applications; methodologies for verification and validation of software that simulates ground effects of launch acoustics; standardization of payload integration and subsystem interfaces to enable low cost, reliable, and reusable standards and adapter systems for launch.

Subtopics

T7.01 Ground Effects of Launch Acoustics

Lead Center: KSC

The exhaust plume from a launch vehicle rocket engine generates severe acoustic waves, which cause acoustic loading on the ground structures and vehicle payload. Prediction and reduction of the acoustic levels in the near field of launch vehicle lift-off is an important factor that should be taken into consideration early in the design process of the space launch complex.

The Kennedy Space Center is dedicated for ground systems operation. It is crucial that ground support equipments (GSE) and launch pad structures are designed to withstand the launch-induced environments produced by the first-stage rocket exhaust plume.

High-fidelity prediction technique such as computational aeroacoustics (CAA) can be used to resolve the acoustic flow field in an accurate fashion. It is understood that CAA prediction can be computationally intensive and often prohibitive for a large domain as in the launch environment. However, recent advances in computational resources and methodology have allowed CAA to overcome these difficulties. In the past few years, researchers have employed CAA in the launch environment^{1, 2, 3}. These results are promising, but they need to be validated against actual data. The economical way of getting acoustic data is from static firing in a subscale or full scale environment. The problem with static firing test is that they do not reveal the dynamic environment. Flight data from actual launch would yield much better data, but such data are limited and costly. The best alternative would be to collect data from a demonstration launch vehicle.

It is proposed that a capability be developed to perform launch acoustics research by launching a demonstration reusable vehicle from one of the launch pads at KSC or Cape Canaveral Air Force Station (CCAFS), with acoustic sensors installed on the vehicle and in the vicinity of the launch complex. The capability will allow raw data to be processed into one-third octave band sound pressure level and used for benchmarking results obtained from CAA analysis.

References:

- Tsutsumi, S., Kato, S., Fukuda, K., and Takaki, R., "Effect of Deflector Shape on Acoustic Field of Launch Vehicle at Lift-off", AIAA-2009-3028, 47th AIAA Aerospace Sciences Meeting, Orlando, FL, 5-8 January 2009.
- Tsutsumi, S., Kato, S., Fukuda, K., and Takaki, R., "Numerical Study on Acoustic Radiation for Designing Launch-Pad of Advance Solid Rocket," AIAA-2008-5148, 44th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit, Hartford, CT, 21-23 July 2008.
- Casalino, D., Barbarino, M., Genito, M., and Ferrara, V., "Improved Empirical Methods for Rocket Noise Prediction through CAA Computation of Elementary Source Fields, 14th AIAA/CEAS Aeroacoustics Conference, 5-7 May 2008, Vancouver, BC, Canada.

T7.02 Payload Integration and Payload Launch Preparation Interface Standards

Lead Center: KSC

This STTR topic seeks commercial solutions that will allow and encourage standardization of key payload to launch vehicle, and subsystem interface standards to reduce the cost associated with analysis, integration, and preparation required to design and then configure space systems for launch. The goal is a set of launch vehicle adapters, processes, and avionics interface standards that can be collectively used to facilitate spacecraft and subsystem design while reducing testing duration and complexity, overall reducing mission risk and while enabling novel mission concepts.

These sets of systems will focus on new standards for payload in the following mass ranges:

- 1 to 10kg.
- 11 to 50kg.
- 51 to 100kg.

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- 101 to 180kg.

These ranges have been identified as the regions where critical technologies demonstrations and new space technologies could be used to increase TRL level at a lower cost with reduced risk. Enabling these capabilities will allow space craft developers the ability to design to a specific mass range that will result in on orbit research.

This STTR will be used to evaluate each of the current and future launch vehicles in determining where cross cutting standards can be applied to the entire NASA launch vehicle fleet.

The STTR has been classified as highly desirable. This rating was determined because there are adapters in place that could support the missions. However, to have multiple systems across multiple launch vehicles will contribute to higher cost for integration of that mission. By having standards amongst the space craft and adapter community will reduce the per kilogram cost to orbit.

A significant fraction of mission costs are typically unique designs and approaches to perform relatively routine functions such as launch accommodations and subsystem-to-subsystem interface and communications. By standardizing many of these approaches, spacecraft and payload developers can design their systems with an expectation of a predictable, low-cost integration flow. Launch service providers can mitigate mission risk through the use of predictable and proven interfaces standardized to streamline analytical/physical integration processes and test flows.

Specific areas of interest:

- Launch adapters and systems and associated spacecraft standards.
- Standardized spacecraft and/or payload integration test flows, processes and qualification techniques.
- Standardized electrical interface standards, sometimes known as plug and play electrical power and data bus standards for streamlined subsystem integration.

Priority should be given to practical solutions that:

- Enable low-cost and reliable reusable standards and adapter systems.
- Demonstrate a higher likelihood of being incorporated into a wide number of commercial or government space access system, or systems.
- Can achieve flight or high-fidelity ground-based demonstrations within the next three years; longer-term

development proposals will be accepted, but will be considered at a lower priority for funding.

T7.03 Flexible Polymer Foams Systems for Fireproofing and Energy Absorption

Lead Center: KSC

NASA has a growing need for flexible polymer foams for cryogenic insulation, fireproofing, energy absorption and other aerospace applications. NASA Chemists and Engineers at Langley Research Center and Kennedy Space Center have been developing high performance polyimide foams for the last 15 years or more for such applications with great success in varying densities, addressing cell content and effects on performance properties, and additionally producing composites of such foams with enhanced thermal conductivity. In addressing applications for these high performance foams, it has also been identified that increased flexibility with structural integrity foams are also needed in polyurethane foam systems. Advances in novel approaches to polyurethane foam systems are desired to address increased flexibility, good flame retardancy and acoustic attenuation properties for future vehicle and ground systems. The goal is explore new flexible foam systems that control cell content and offer "breathable" characteristics allowing for foam use in potential ice mitigation in such applications as umbilical systems. Delayed time to ignition, decreased peak heat release rates and smoke generation in non-halogen flame retardancy are also advantageous for response to this solicitation.